Name: Rosetta
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Abstract

Mathematical models have become increasingly popular in the research and management of flow and transport processes in the subsurface environment. The unsaturated hydraulic functions are key input data in numerical models of vadose zone processes. These functions may be either measured directly or estimated indirectly through prediction from more easily measured data based upon quasi-empirical models. Rosetta V1.0 is a Windows 95/98 program to estimate unsaturated hydraulic properties from surrogate soil data such as soil texture data, bulk density. Models like this are often called pedotransfer functions (PTFs) because they translate basic soil data into hydraulic properties. Rosetta can be used to estimate the following properties

- Water retention parameters according to van Genuchten (1980)
- Saturated hydraulic conductivity
- Unsaturated hydraulic conductivity parameters according to van Genuchten (1980) and Mualem (1976)

Rosetta offers five (PTFs) that allow the prediction of the hydraulic properties with limited or more extended sets of input data. This hierarchical approach is of a great practical use because permits optimal used of available input data. The models use the following input data

- Soil textural classes
- Sand, silt and clay percentages
- Sand, silt and clay percentages and bulk density
- Sand, silt and clay percentages, bulk density
  and a water retention point at 330 cm (33 kPa).
- Sand, silt and clay percentages, bulk density
  and water retention point at 330 and 15000 cm (33 and 1500 kPa)

The first model is based on a lookup table that provides class average hydraulic parameters for each USDA soil textural class (this table is given below). The other four models are based on neural network analysis and provide more accurate predictions when more input data variables are used. In addition to the hierarchical approach, we also offer a model that allows the prediction of unsaturated hydraulic conductivity parameters from fitted van Genuchten (1980) retention parameters (Schaap and Leij, 1999). This model is also used in the hierarchical approach where it automatically uses the *predicted* retention parameters as input instead of measured (fitted) retention parameters

All estimated hydraulic parameters are accompanied by uncertainty estimates that allow an assessment of the reliability of Rosetta's predictions. These uncertainty estimates were generated by combining the neural networks with the bootstrap method, see Schaap and Leij (1998) and Schaap et al. (1999) for more information.

Data input and output

Rosetta is based on the ACCESS-97 database tables which allow efficient handling and lookup of small and large volumes of data. Data can be either manually entered or read from ASCII files. The maximum amount of samples (records) that Rosetta can handle is limited by the available hard disk space. Estimated hydraulic properties can be exported in ASCII files and used in other programs. ACCESS-97 is not required to run Rosetta, however, ACCESS-97 can be used to manage Rosetta's predictions in a bigger project, provided that the tables created by Rosetta are not altered.

Downloading and installing Rosetta

The compressed ROSETTA.EXE file which can be downloaded from our FTP site, using our USSL FTP Access Page. Download ROSETTA.EXE from our USSL FTP Access Page (approximately 3 MB) and store this file in a temporary directory, then run it from the windows start menu (Start-Run…). Then go to the start menu again and run SETUP.EXE from the same directory as you used for ROSETTA.EXE. This will install Rosetta on your PC, Rosetta will take up less than 6 MB of disk space when installed.

Help system and tutorials

Rosetta contains an extensive help file that explains you how to use the various menu options and screens. The help system also contains two tutorials that illustrate most functions in Rosetta. Further, the help system contains extensive information about the background of Rosetta (data used for calibration, calibration results, neural networks and the bootstrap method)

Bug reports

Although we have tried our best to make Rosetta error free, it is possible that you may encounter bugs. Please notify mschaap@ussl.ars.usda.gov of any problems regarding the program and the conditions under which they occurred.

Hydraulic functions used by Rosetta

The present version of Rosetta is capable of predicting van Genuchten (1980) water retention and unsaturated hydraulic conductivity parameters, as well as to provide estimates of saturated hydraulic conductivity, Ks. The van Genuchten water retention function is given by:

$$\theta(h) = \theta_r + \frac{\theta_s - \theta_r}{[1+(\alpha h)^n]^{1-1/n}}$$

where*q*(*h*) represents the water retention curve defining the water content, θ (cm^3/cm^3), as a function of the soil water pressure head *h* (cm), θ_r and θ_s (cm^3/cm^3) are residual and saturated water contents, respectively, while α (1/cm) and *n* are curve shape parameters. This equation can be rewritten to yield the relative saturation, S_e:

$$S_e = \frac{\theta(h) - \theta_r}{\theta_s - \theta_r} = [1+(\alpha h)^n]^{1/n-1}$$

This equation is used in conjunction with the pore-size distribution model by Mualem (1976) to yield the van Genuchten-Mualem model (van Genuchten, 1980):

$$K(S_e) = K_o\, S_e^L \{1-[1-S_e^{n/(n-1)}]^{1-1/n}\}^2$$

in which K_o is the matching point at saturation (cm/day) and similar, but not necessarily equal, to the saturated hydraulic conductivity, K_s. The parameter L (-) is an empirical pore tortuosity/connectivity parameter that is normally assumed to be 0.5 (*Mualem*, 1976). Rosetta predicts L which will be negative in most cases. Although this leads to some theoretical complications, negative L give far better results (cf. Kosugi, 1999; Schaap and Leij, 1999).

Class average values of hydraulic parameters

The table below gives class-average values of the seven hydraulic parameters for the twelve USDA textural classes. Effectively, this table represents the first model of the hierarchical sequence. For the θr, θs, α, n and Ks parameters, the values have been generated by computing the average values for each textural class. For Ko and L the values were generated by inserting the class average values of θr, θs, α, n into Model C2 (see Rosetta's help file). This means that Ko and L are based on predicted parameters and may not be very reliable. The values in parenthesis give the one standard deviation uncertainties of the class average values.

Texture Class	N	—— θr —— cm3/cm3		—— θs —— cm3/cm3		—— log(α) —— log(1/cm)		—— log(n) —— log10		—— Ks —— log(cm/day)		—— Ko —— log(cm/day)		—— L ——	
Clay	84	0.098	(0.107)	0.459	(0.079)	-1.825	(0.68)	0.098	(0.07)	1.169	(0.92)	0.472	(0.26)	-1.561	(1.39)
C loam	140	0.079	(0.076)	0.442	(0.079)	-1.801	(0.69)	0.151	(0.12)	0.913	(1.09)	0.699	(0.23)	-0.763	(0.90)
Loam	242	0.061	(0.073)	0.399	(0.098)	-1.954	(0.73)	0.168	(0.13)	1.081	(0.92)	0.568	(0.21)	-0.371	(0.84)
L Sand	201	0.049	(0.042)	0.390	(0.070)	-1.459	(0.47)	0.242	(0.16)	2.022	(0.64)	1.386	(0.24)	-0.874	(0.59)
Sand	308	0.053	(0.029)	0.375	(0.055)	-1.453	(0.25)	0.502	(0.18)	2.808	(0.59)	1.389	(0.24)	-0.930	(0.49)
S Clay	11	0.117	(0.114)	0.385	(0.046)	-1.476	(0.57)	0.082	(0.06)	1.055	(0.89)	0.637	(0.34)	-3.665	(1.80)
S C L	87	0.063	(0.078)	0.384	(0.061)	-1.676	(0.71)	0.124	(0.12)	1.120	(0.85)	0.841	(0.24)	-1.280	(0.99)
S loam	476	0.039	(0.054)	0.387	(0.085)	-1.574	(0.56)	0.161	(0.11)	1.583	(0.66)	1.190	(0.21)	-0.861	(0.73)
Silt	6	0.050	(0.041)	0.489	(0.078)	-2.182	(0.30)	0.225	(0.13)	1.641	(0.27)	0.524	(0.32)	0.624	(1.57)
Si Clay	28	0.111	(0.119)	0.481	(0.080)	-1.790	(0.64)	0.121	(0.10)	0.983	(0.57)	0.501	(0.27)	-1.287	(1.23)
Si C L	172	0.090	(0.082)	0.482	(0.086)	-2.076	(0.59)	0.182	(0.13)	1.046	(0.76)	0.349	(0.26)	-0.156	(1.23)
Si Loam	330	0.065	(0.073)	0.439	(0.093)	-2.296	(0.57)	0.221	(0.14)	1.261	(0.74)	0.243	(0.26)	0.365	(1.42)

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